

Significant asymmetries in the fluid dynamics were calculated for some cases in the CFD simulations of the Orion Launch Abort Vehicle through its abort trajectories. The CFD simulations were performed steady state with symmetric boundary conditions and geometries. The trajectory points at issue were in the transonic regime, at  $0^\circ$  and  $\pm 5^\circ$  angles of attack with the Abort Motors with and without the Attitude Control Motors (ACM) firing. In some of the cases the asymmetric fluid dynamics resulted in aerodynamic side forces that were large enough that would overcome the control authority of the ACMs. MSFC's Fluid Dynamics Group supported the investigation into the cause of the flow asymmetries with time accurate CFD simulations, utilizing a hybrid RANS-LES turbulence model. The results show that the flow over the vehicle and the subsequent interaction with the AB and ACM motor plumes were unsteady. The resulting instantaneous aerodynamic forces were oscillatory with fairly large magnitudes. Time averaged aerodynamic forces were essentially symmetric.